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PENSOFT

A new occurrence of *Mucor nidicola* (Madden, Stchigel, Guarro, Sutton & Starks) (Mucorales, Mucoromycota) in the Upland Rainforest of the Brazilian Northeast and first report as a saprobe in soil

Diogo Xavier Lima, Thalline Rafhaella Leite Cordeiro, Catarina Letícia Ferreira de Lima, Carlos Alberto Fragoso de Souza, André Luiz Cabral Monteiro de Azevedo Santiago, Cristina Maria Souza-Motta

Graduate Program in Biology of Fungi, Department of Mycology, Federal University of Pernambuco, Av. Professor Nelson Chaves, s/n, 50670-420, Recife, PE, Brazil.
Corresponding author: Diogo Xavier Lima, diogo_xavier00@hotmail.com

Abstract
Mucor nidicola, a mucoralean fungus, was isolated for the first time from a wasp nest in Massachusetts, USA, and then reported in the state of Paraná, Brazil, as an entomopathogenic fungus collected from insects in strawberry crops. This work reports the first occurrence of *M. nidicola* from soil in the Brazilian Northeast. This species is distinguished from other species by producing erect, unbranched, and once-branched sporangiophores, globose to subglobose columellae, and mostly ellipsoidal sporangiospores, but with some irregular and varying in size and shape.

Keywords
ITS rDNA; Mucoromyceta; taxonomy.

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Introduction

Braziliam Upland Rainforests are in elevated areas that range from 500 to 1100 m in altitude and belong to the Atlantic Forest domain. These areas are within the semi-arid region of northeast Brazil, but due to the altitude, they show moderate temperatures and high moisture in comparison to the surrounding caatinga vegetation (Tabarelli and Santos 2004), factors which favor the high biodiversity of these forests (Myers et al. 2000; Ribeiro et al. 2008). Surveys on the diversity of mucoralean fungi in Brazilian Upland Rainforests have reported several taxa of *Mucor*, including four new species (Guo Jie Li et al. 2016; de Souza et al. 2018; Lima et al. 2018).

The genus *Mucor*, proposed by Fresenius (1850), comprises the largest number of species within the order Mucorales Fr., which in turn belongs to the subphylum Mucoromycotina Benny and the phylum Mucoromycota Doweld (Spatafora et al. 2016). The species of this genus are characterized by the production of unbranched and/or branched sporangiophores, as well as globose, unapophysate sporangia with deliquescent or persistent walls (Benny 2013). According to Wijayawardene (2018), nearly 60 species of *Mucor* are accepted, albeit

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the exact number of valid taxa is unknown (Gherbawy et al. 2010).

Mucor nidicola has only been reported as an entomopathogenic fungus in the USA, South Korea, and Brazil (Madden et al. 2012; Ahn et al. 2016; Nguyen et al. 2016; Poitevin et al. 2018) and as an endophyte of banana rachises in Colombia (Méndez-Castillo et al. 2017). Here we present a description of *M. nidicola* isolated from soil samples in an Upland Rainforest area located in the state of Pernambuco, Brazil. This is the first report of this species in soil as well as in the Brazilian Northeast.

Methods

The soil samples were collected in October 2018 in the city of Garanhuns (Fig. 1), which is in the state of Pernambuco, Brazil. For isolation, 5 mg of soil were added to Petri dishes containing wheat germ agar medium (Benny 2008) amended with chloramphenicol (80 mg/L). Plates were incubated on the laboratory at 25 °C for 7 days in alternate periods of light and dark. Fungal biomass was obtained for genomic DNA extraction as described by Góes-Neto et al. (2005). The primer pairs ITS1/ITS4 (White et al. 1990) were used to amplify the ITS region of rDNA. A polymerase chain reaction was conducted as described by Oliveira et al. (2014). The final amplicons were purified with the InvitrogenTM PureLinkTM PCR Purification Kit and sequenced. The newly obtained sequence was deposited in GenBank. The specimen was identified by the observation of the macroscopic (coloration, appearance, and diameter of the colonies) and microscopic (microstructures) characteristics, according to the description of Madden et al. (2012).

Results

Material examined. BRAZIL• Pernambuco, Garanhuns; 08°56′013″S, 036°27′640″W; 774 m a.s.l.; 10 Oct. 2018, leg. Diogo Xavier Lima (D.X. Lima URM 8170); habitat: soil; GenBank accession no. MN646273.

Distribution. Brazil, Colombia, USA, and South Korea.

Identification. *Mucor nidicola* (Madden, Stchigel, Guarro, Sutton & Starks), International Journal of Systematic and Evolutionary Microbiology 62: 1710–1714. 2012. Figure 2A–H.

Colonies light yellow to brownish (MP 114C), reverse yellow (MP 114D), growing rapidly on MEA (9 cm in diameter after 4 days at 25 °C). Sporangiophores erect, 10–15 µm in diameter, unbranched or once-branched. Sporangia smooth-walled, yellowish to brownish, globose, 30–70 µm in diameter, with wall deliquescent but persistent in young sporangia. Columellae smooth-walled, hyaline, globose to subglobose 5–40 × 20–45

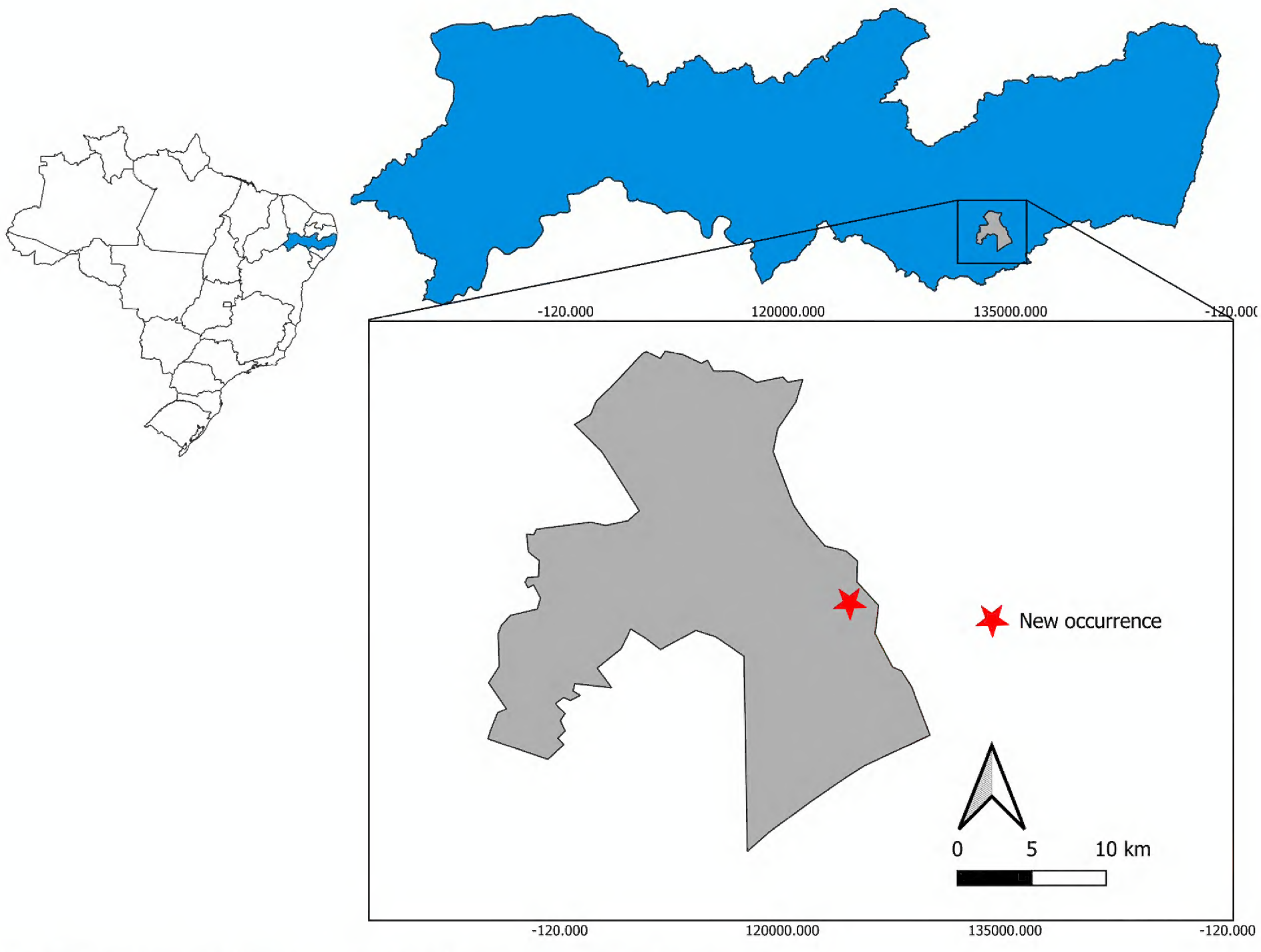

Figure 1. The location in Garanhuns city, where *Mucor nidicola* URM 8170 was found.

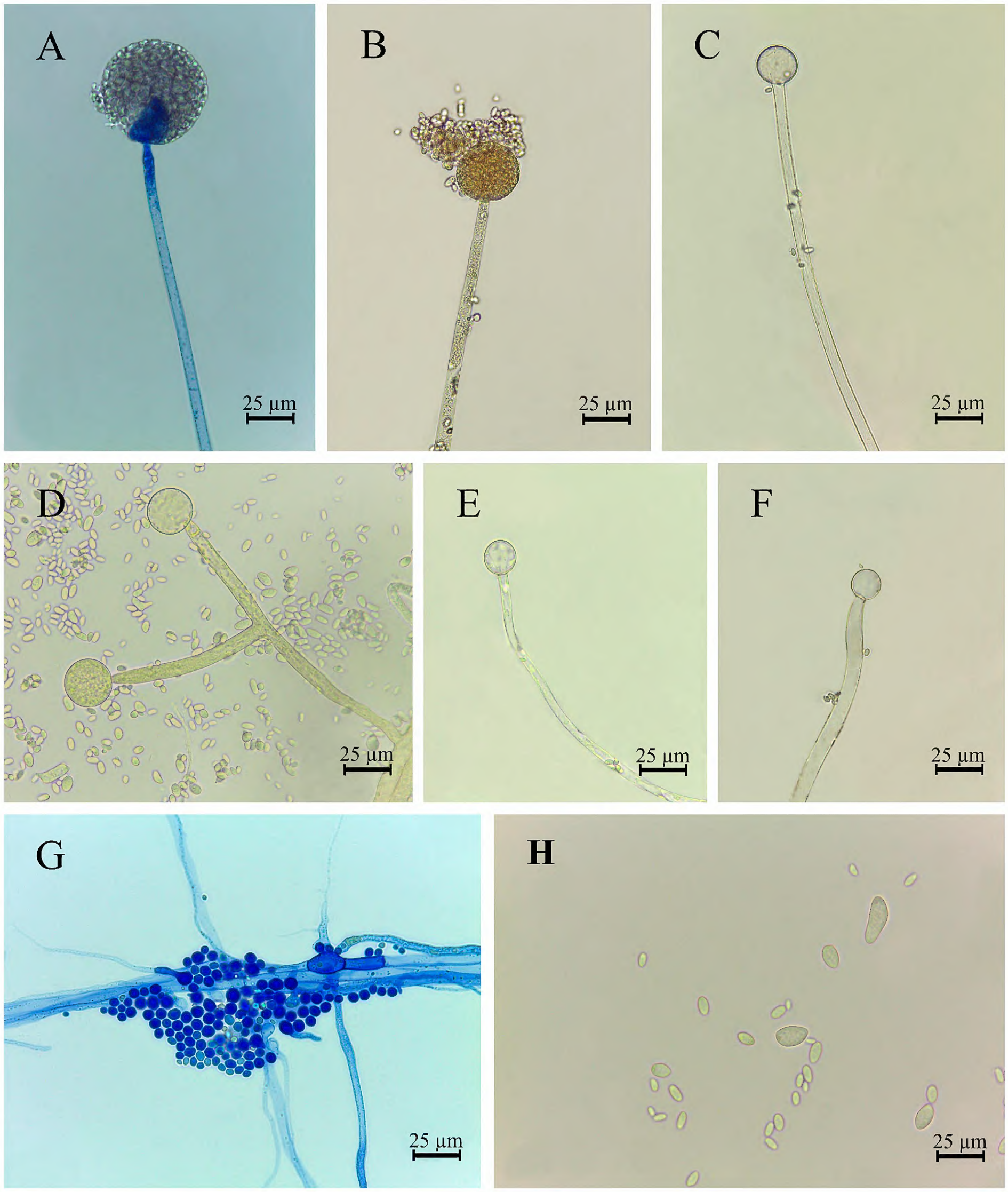

Figure 2. *Mucor nidicola*. **A, B.** Unbranched sporangiophore with sporangium. **C, E, F.** Unbranched sporangiophores and columella. **D.** Sporangiophores branched once. **G.** Chlamydospores. **H.** Sporangiospores.

µm. Collar evident. Sporangiospores mostly ellipsoidal, 3–10 × 2–6 µm, some irregularly shaped, 12–20 × 5–12 µm, light greyish, smooth-walled. Chlamydospores globose or barrel-shaped, thick-walled zygosporangia not observed. Probably heterothallic.

Discussion

The specimen studied was isolated from soil. This same species was found in a wasp nest, mushroom flies, guts of soldier fly larvae, insects in strawberry crops, and endophytic in bananas (Madden et al. 2012; Ahn et al. 2016; Nguyen et al. 2016; Méndez-Castillo et al. 2017; Poitevin et al. 2018). The morphological characteristics of *M. nidicola* URM 8170 show close similarity to the original description by Madden et al. (2012), although we observed a few variations in relation to the size of the ellipsoid sporangiospores, which are much bigger than those of the holotype (3–10 × 2–6 µm); we have found irregular sporangiospores up to 20 × 12 µm in size. The

color of colonies is slightly different than described by Madden et al. (2012) as orange to greyish-orange, whereas our strain is yellow to brownish. However, we do not consider these differences enough to characterize a new variety. In BLASTn analysis our strain sequence MN646273 (URM 8170) showed 99.33% identity with *M. nidicola* JF299215 (CBS 130359)

We report the first occurrence of *M. nidicola* in northeastern Brazil and its first report as saprobe, isolated specifically from soil of a Brazilian Upland Rainforest area, contributing to the knowledge of the geographical distribution of mucoralean fungi.

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Authors' Contributions

TRLC and CLFL collected the material; CAFS performed the specified methodology; DXL and CSM wrote the text; ALCMAS and DXL identified the species.

References

Ahn GR, Kwon HW, Ko HK, Kim SH (2016) Unrecorded fungal species isolated from greenhouses used for shiitake cultivation in Korea. Korean Journal of Mycology 44 (1): 8–15. https://doi.org/10.4489/KJM.2016.44.1.8

Benny GL (2008) The methods used by Dr. R.K. Benjamin, and other mycologists to isolate Zygomycetes. Aliso 26 (1): 37–61. https://doi.org/10.5642/aliso.20082601.08

Benny GL (2013) Zygomycetes. http://zygomycetes.org/index.php?id=84. Accessed on: 2019-5-6.

Gherbawy Y, Kesselboth C, Elhariry H, Hoffmann K (2010) Molecular barcoding of microscopic fungi with emphasis on the mucoralean genera *Mucor* and *Rhizopus*. In: Gherbawy Y, Voight K (Eds) Molecular identification of fungi. Springer-Verlag, Berlin/Heidelberg, 225–265.

Góes-Neto A, Loguercio-Leite C, Guerrero RT (2005) DNA extraction from frozen fieldcollected and dehydrated herbarium fungal basidiomata:performance of SDS and CTAB-based methods. Biotemas 18 (2): 19–32.

Lima CLF, Lima DX, Souza CAF, Oliveira RJV, Cavalcanti IB, Gurgel LMS, SantiagoALCM de A (2018) Description of *Mucor pernambucoensis* (Mucorales, Mucoromycota), a new species isolated from the Brazilian Upland Rainforest. Phytotaxa 350 (3): 274–282. http://doi.org/10.11646/phytotaxa.350.3.6

Li GJ, Hyde KD, Zhao RL, Hongsanan S, Abdel-Aziz FA, Abdel-Wahab MA, Alvarado P, Alves-Silva G, Ammirati JF, Ariyawansa HA, Baghela A, Bahkali AH, Beug M, Bhat DJ, Bojantchev D, Boonpratuang T, Bulgakov TS, Camporesi E, Boro MC, Ceska O, Chakraborty D, Chen JJ, Chethana KWT, Chomnunti P, Consiglio G, Cui BK, Dai DQ, Dai YC, Daranagama DA, Das K, Dayarathne MC, De Crop E, De Oliveira RJV, de Souza CAF, de Souza JI, Dentinger BTM, Dissanayake AJ, Doilom M, Drechsler-Santos ER, Ghobad-Nejhad M, Gilmore SP, Góes-Neto A, Gorczak M, Haitjema CH, Hapuarachchi KK, Hashimoto A, He MQ, Henske JK, Hirayama K, Iribarren MJ, Jayasiri SC, Jayawardena RS, Jeon SJ, Jerônimo GH, Jesus AL, Jones EBG, Kang JC, Karunarathna SC, Kirk PM, Konta S, Kuhnert E, Lagner, E, Lee HS, Lee HB, Li WJ, Li XH, Liimatainen K, Lima DX, Lin CG, Liu JK, Liu XZ, Liu ZY, Luangsa-ard JJ, Lücking R, Lumbsch HT, Lumyong S, Leaño EM, Marano AV, Matsumura M, McKenzie EHC, Mongkolsamrit S, Mortimer PE, Nguyen TTT, Niskanen T, Norphanphoun C, O'Malley MA, Parnmen S, Pawlowska J, Perera RH, Phookamsak R, Phukhamsakda C, Pires-Zottarelli CLA, Raspé O, Reck MA, Rocha SCO, de Santiago ALCMA, Senanayake IC, Setti, L, Shang QJ, Singh SK, Sir EB, Solomon KV, Song J, Sriktikulchai P, Stadler M, Suetrong S, Takahashi H, Takahashi T, Tanaka K, Tang LP, Thambugala KM, Thanakitpipattana D, Theodorou MK, Thongbai B, Thummarukcharoen T, Tian Q, Tibpromma S, Verbeken A, Vizzini A, Vlasák J, Voigt K, Wanasinghe DN, Wang Y, Weerakoon G, Wen HA, Wen TC, Wijayawardena NN, Wongkanoun S, Wrzosek M, Xiao YP, Xu JC, Yan JY, Yang J, Yang SD, Hu Y, Zhang JF, Zhao J, Zhou LW, Peršoh D, Phillips AJL, Maharachchikumbura SSN (2016) Fungal diversity notes 253–366: taxonomic and phylogenetic contributions to fungal taxa. Fungal Diversity 78 (1): 1–237. https://doi.org/10.1007/s13225-016-0366-9

Madden AA, Stchigel AM, Guarro J, Sutton D, Starks PT (2012) *Mucor nidicola* sp. nov., a fungal species isolated from an invasive paper wasp nest. International Journal of Systematic and Evolutionary Microbiology 62 (7): 1710–1714.https://doi.org/10.1099/ijs.0.033050-0

Méndez Castillo L, Prieto Correa E, Jiménez Junca C (2017) Identification of fungi isolated from banana rachis and characterization of their surface activity. Letters in applied microbiology 64 (3): 246–251. https://doi.org/10.1111/lam.12712

Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GAB, Kent J (2000) Biodiversity hotspots for conservation priorities. Nature 24: 853–858. https://doi.org/10.1038/35002501

Nguyen TTT, Duong TT, Lee HB (2016) Characterization of two new records of mucoralean species isolated from gut of soldier fly larva in Korea. Mycobiology 44 (4): 310–313. https://doi.org/10.5941/myco.2016.44.4.310

Oliveira RJV, Lima TEF, Cunha IB, Coimbra VRM, Silva GA, Bezerra JL, Cavalcanti MAQ (2014) *Corniculariella brasiliensis*, a new species of coelomycetes in the rhizosphere of *Caesalpinia echinata* (Fabaceae, Caesalpinioideae) in Brazil. Phytotaxa 178 (3): 197–204. http://doi.org/10.11646/phytotaxa.178.3.5

Poitevin CG, Porsani MV, Poltronieri AS, Zawadneak MAC, Pimentel IC (2018) Fungi isolated from insects in strawberry crops act as potential biological control agents of *Duponchelia fovealis* (Lepidoptera: Crambidae). Applied Entomology and Zoology 53 (3): 323–331. http://doi.org/10.1007/s13355-018-0561-0

Rodrigues PCG, Chagas MGC, Silva FBR, Pimentel RMM (2008) Ecologia dos brejos de altitude do agreste pernambucano. Revista de Geografia 25 (3): 20–34.

Spatafora JW, Chang Y, Benny GL, Lazarus K, Smith ME, Berbee ML, Bonito G, Corradi N, Grigoriev I, Gryganskyi A, James TY,

O'Donnell K, Roberson RW, Taylor TN, Uehling J, Vilgalys R, White MM, Stajich JE (2016) A phylum-level phylogenetic classification of zygomycete fungi based on genome-scale data. Mycologia 108 (5): 1028–1046. https://doi.org/10.3852/16-042

de Souza C A, Voigt K, Gurgel LS, Cordeiro TR, Oliveira RJ, Lima DX, Santiago ALDA (2018) A new species of *Mucor* (Mucoromycotina, Mucorales) isolated from an enclave of Upland Atlantic Forest in the semi-arid region of Brazil. Phytotaxa 351 (1): 53–62. http://doi.org/10.11646/phytotaxa.351.1.4

Tabarelli M, Santos AMM (2004) Uma breve descrição sobre a história natural dos brejos nordestinos. In: Porto KC, Cabral JJP, Tabarelli M (Eds) Brejos de altitude em Pernambuco e Paraíba: história natural, ecologia e conservação. Ministério do Meio Ambiente, Brasília, 299–302.

Wijayawardene NN, Pawłowska J, Letcher PM, Kirk PM, Humber RA, Schüßler A, Wrzosek M, Muszewska A, Okrasinka A, Istel L, Gesiorska A, Mungai P, Lateef AA, Rajeshkumar KC, Singh RV, Radek R, Walther G, Wagner L, Walker C, Wijesundara DSA, Papizadeh M, Dolatabadi S, Shenoy BD, Tokarev YS, Lumyong S, Hyde KD (2018) Notes for genera: basal clades of Fungi (including Aphelidiomycota, Basidiobolomycota, Blastocladiomycota, Calcarisporiellomycota, Caulochytriomycota, Chytridiomycota, Entomophthoromycota, Glomeromycota, Kickxellomycota, Monoblepharomycota, Mortierellomycota, Mucoromycota, Neocallimastigomycota, Olpidiomycota, Rozellomycota and Zoopagomycota). Fungal Diversity 92: 43–129. http://doi.org/10.1007/s13225-018-0409-5

White TJ, Bruns T, Lee S, Taylor J (1990) Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ (Eds) PCR protocols:a guide to methods and applications. Academic Press, New York, 315–322.